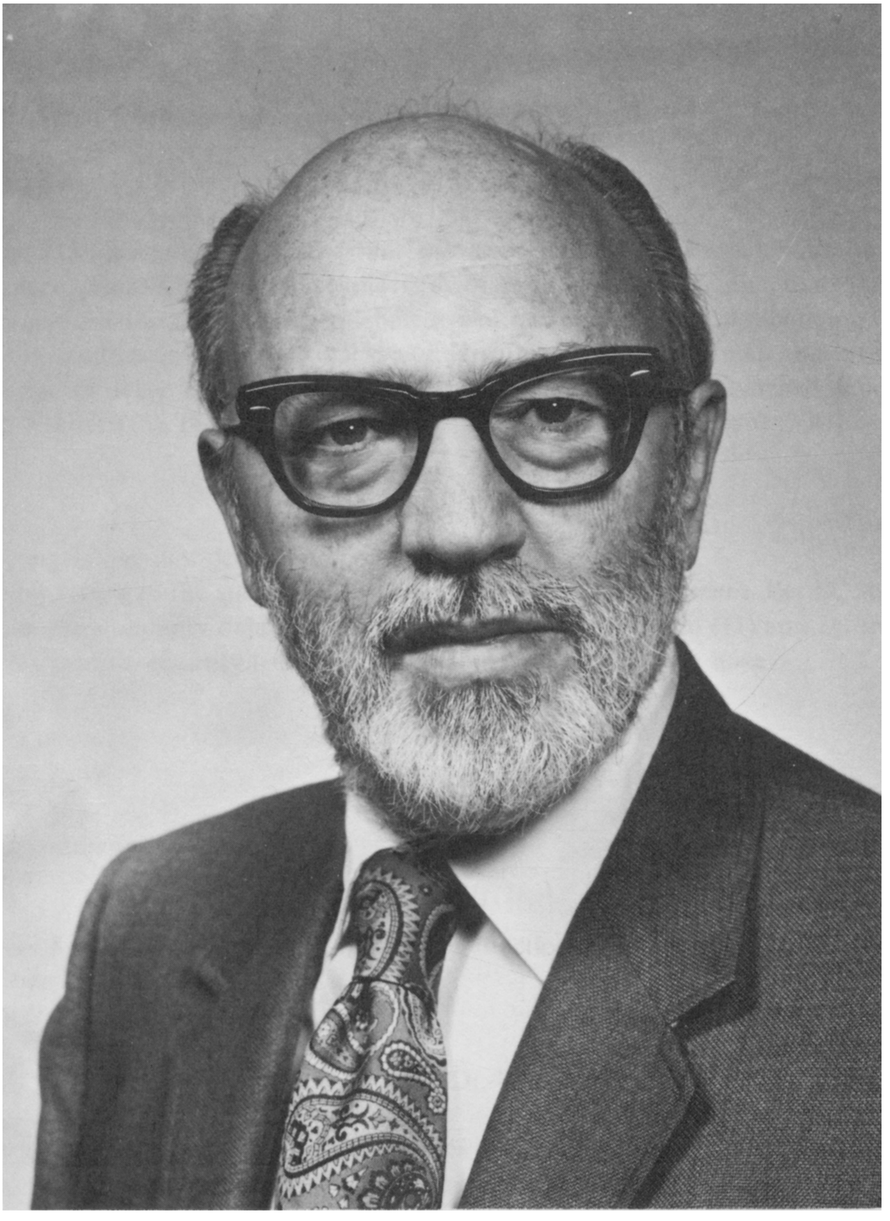

Leo Katz 1914–1976

Obituary: LEO KATZ

On 6 May 1976 the academic world and the international community of statisticians lost one of its pioneers—Leo Katz. His major activity and life's work were devoted to statistics, but there is also a personal story that is of interest.

Leo was born on 29 November 1914 in Detroit, Michigan to immigrant Jewish parents. Thirteen years later his father contracted tuberculosis and the Katz family moved to Denver hoping that the fresh mountain air would effect a cure. The hope was in vain and Leo's father died one year later leaving Leo, his younger brother, and his mother to face an insecure future. Though only 15 and still in high school, Leo helped shoulder major family responsibilities. The three survivors later returned to Detroit where his mother's re-marriage lessened the financial pressures.

In 1933, when the Great Depression reached its lowest depths, Leo enrolled at the Lawrence Institute of Technology. During his second year at Lawrence, at the age of 19, he became ill with diabetes. Despite this Leo continued his work and schooling and received his B.A. degree in electrical engineering in 1936. In 1938, Leo received his M.A. degree in mathematics from Wayne State University and entered the doctoral program at the University of Michigan. He continued his studies while working first as a statistician at Wayne University, then at the Michigan Department of Labor, and later as a mathematician at General Motors.

In 1945, when he had just passed his thirtieth birthday, Leo was again afflicted with illness—tuberculosis. It took him one year in a sanatorium to recover. While recuperating at home, Leo completed his doctoral dissertation, wrote his first article on sociological statistics and received his Ph.D. in statistics from the University of Michigan. He went to Michigan State University in September 1946.

Leo's life exemplifies the hardship and the strengths of the depression generation, and his experience no doubt contributed to his strong liberal social conscience and his dedication to intellectual pursuit. He was an early supporter of the Teachers Union, was a lifelong member of the American Civil Liberties Union, and was politically active. His voice was one of the first to be raised against the war in Vietnam. On the scholarly side he took ideas seriously and was critical of anything less than the most rigorous use of statistics. He believed in statistics not only as theoretical study but as a tool to make knowledge more effective in solving important problems of our society.

The decade 1950–1960 was a period of growth of statistics, and the movement for separate departments began during these years. Anyone involved in the formation of a department knows the amount of effort required. Leo was the driving force in setting up a separate department at Michigan State University.

In spite of many uncertainties and countless discussions, the department became a reality in 1956 with Leo as Head. In this role, Leo built an exciting group, and attracted many visitors. Today the department continues as a flourishing organization and a tribute to the efforts of Leo Katz.

At Michigan State Leo enjoyed fostering students and young faculty. He worked very well with graduate students, gave his time to them unstintingly, and never let the student suffer from the doubts of his own ability. Leo was always available and helpful to young faculty members, and encouraged them to develop their research interests.

During his 30 years of association with Michigan State University, Leo frequently visited at other institutions including the University of California at Berkeley, Stanford University, and the College of Medicine of the University of Cincinnati. He was Scientific Liaison Officer for the Office of Naval Research, London, 1959-60, Ford Foundation Visiting Distinguished Professor at the University of North Carolina, 1961-62, an Alcoa Foundation Professor at the University of Pittsburgh, 1968-69, and a NATO Senior Fellow at the Technion in Haifa and the University of Leeds.

He was also actively involved in professional societies. For the Institute of Mathematical Statistics he was Program Co-ordinator during 1957-59, member of the Council 1959-61, 1968-73, Executive Secretary 1968-73, and Editor of the IMS Bulletin 1972-74. He was a member of the Council of the American Statistical Association 1971-73, a participant in the Visiting Lecturer Program 1963-66, a member of the Mathematical Association of America Committee on Undergraduate Program in Mathematics, 1966-67 and Chairman of the Michigan Consumers Council 1966-69.

Leo's two main areas of research were combinatorics and applied probability models. Both areas are quite popular today, but much of this work was innovative in the early 1950's.

In 1946 Leo was asked to try to develop more effective methods of handling some sociological data collected by the Detroit Citizenship Education Study Staff. This led to the important idea of representing sociological relationships by graphs and their associated matrices, and permitted the use of a whole calculus of operations to help analyse such data. His first paper (1946) on this subject entitled 'A matrix approach to the analysis of sociometric data' was joint with E. Forsyth.

To review his contributions on this subject, consider a directed graph on N points $P_1, \cdots, P_N$, where for any two points P_i and P_j there is either a connection $\overrightarrow{P_iP_j}$, or no connection between P_i and P_j. This graph may be represented in terms of a matrix $A = (a_{ij})$, where $a_{ij} = 1$ if the connection $\overrightarrow{P_iP_j}$ holds, and $a_{ij} = 0$, otherwise (for convention, $a_{ii} = 0$). In the context of sociometric data analysis, each of N individuals is asked to state if a relationship exists between them and

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each of the remaining $N-1$ individuals. For example, the 'relation' might be acceptable flying partners for pilots. In some contexts, the number of choices, d, in each row may be a fixed integer; in other contexts, d may be equal to $N-1$.

If the sum of the elements of the jth column is zero, then individual j is called an *isolate*. Under the assumption that all graphs are equally likely, Lazarsfeld, in 1938, found the expected number of isolates. In 1952, Leo obtained the complete probability distribution, and showed that a very good approximation to this distribution is obtained by fitting a beta distribution with the same first two moments.

A *mutual* occurs when points P_i and P_j are connected in each direction, so that $a_{ij} = a_{ji} = 1$. The paper by Katz and Wilson (1956) addresses this problem, and gives the mean and variance of the number, M, of mutuals; these are used to obtain a normal approximation to the distribution of M. The number of mutuals has become an important tool in the analysis of small groups. For example, somewhat later Leo helped analyse data dealing with a study of reciprocal choices in political groups.

In another context, suppose that each person makes a fixed number, R, of rejections, and in a joint paper with Tagiuri and Wilson (1958), the mean and variance of R are determined.

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Leo (1955) extended his interest to random mappings. Suppose we have N points $P_1, \cdots, P_N$, and to each point P_i we assign an image point $P_j (j = 1, \cdots, N)$ each with probability $1/N$. Thus the sample space consists of N^N possible mappings. The number of distinct image points, X, is a random variable which can take the values $1, 2, \cdots, N$. When $X = 1$ the mapping is indecomposable and cannot be separated into sets of mappings with fewer points. Leo found the probability of indecomposability and showed that $P\{X = 1\}$ is approximately $\sqrt{\pi/(2N)}$ for large N.

A mapping arising in a sociometric context does not permit a point to map into itself. In this case the probability of indecomposability has a different expression which for large N is approximately $e\sqrt{\pi/(2(N-1))}$.

Suppose there are N points and to each point P_i there is associated a pair of numbers r_i, s_i, where r_i is the number of lines from P_i and s_i the number of lines to P_i. The total number of directed lines is t, so that $\Sigma r_i = \Sigma s_j = t$. In their 1954 paper, Katz and Powell determined the number of distinct graphs satisfying the constraints and in a later paper (1957), imposed a probability structure on these graphs. They discuss the distribution of the number of isolated points.

Katz and Proctor (1959) carried the study of sociometric configurations in a different direction by imposing a time element and looking at a change in configurations over time. This suggested an analysis based on Markov chains, which they developed.

The problem of defining a simple index to summarize different geometric configurations is of prime importance to the practitioner. A variety of indices has been proposed, but seldom with any rigorous statistical or probabilistic analysis. Leo was concerned generally with this problem. Katz and Powell (1953) looked at two sociometric measurements and developed a measure of dependence based mainly on a contingency table approach, and later (1955) they considered the number of mutuals. Katz (1953) developed an index that provided a measure of 'order' among the members of the group.

Leo's last work on combinatorics was a paper with Sobel (1972), in which a generalized chessboard, R_k^n, of n dimensions with k squares in each dimension is considered. The usual chessboard is R_8^2. The region covered by a rook at a point x is the unit sphere $\{y \in R_k^n \mid d(x, y) < 1\}$, where d is a distance function. After imposing a probabilistic structure on how the rooks are placed on the board, various occupancy probabilities are computed.

Leo was also interested in discrete distributions and contingency tables. His thesis (1945) developed a broad class of discrete probability distributions arising from the Pearson difference equation $f(x+1)/f(x) = P(x)/Q(x)$, where $P(x)$ and $Q(x)$ are polynomials. In particular, when $P(x)/Q(x) = (\alpha + \beta)/(1 + x)$, the class of distributions includes, among others, the Poisson, negative binomial, and Bernoulli. This class of distributions and some statistical properties, are discussed in a 1963 paper.

Katz and Harkness (1967) provide comparisons of the power functions for a test of independence in 2×2 contingency tables. Katz (1950) deals with the relative efficiency of Best Asymptotically Normal (BAN) estimates and, in particular, the relative efficiency of minimum chi-square versus maximum likelihood estimation for a Poisson distribution with parameter λ, and for the binomial test with parameter np, is determined.

Leo was always interested in applied data analysis and was an excellent statistical consultant. In 1939 he helped Wayne University with a Works Project Administration study of 'selective admission of prospective teachers'; in 1941 he worked on a massive study of labor statistics for the Michigan Department of Labor, and in 1943 on 'A study of the spin characteristics of the P-75 airplane and suggested modification of XP-75 to produce the same ellipsoid of inertia' for the General Motors Corporation. His contributions to sociometric analysis were applied as well as theoretical; a paper in 1950 was concerned with punched card techniques for the analysis of multiple level sociometric data.

Leo's development in 1975 of confidence interval ideas as evidence in legal proceedings was an interesting diversion and resulted from his role as expert witness in a number of cases. This field has always had a probabilistic aspect to it, but statistical articles on it have appeared only recently.

After 1960 he became interested in applications that had a medical origin. His

1964 paper (with T. D. Sterling and H. Perry) in the British Journal of Radiology dealt with radiation treatment planning. More recently, under the sponsorship of The Council for Tobacco Research, U.S.A., he worked on probability models dealing with cancer and smoking. Some of his last work dealt with the representation of disease by certain stochastic models.

The last months of Leo's life were spent in Haifa, Israel where he was a NATO Senior Fellow at the Technion. Leo was enjoying a heightened level of productivity and colleague relationships. During part of his stay, his wife Jeannie was with him and their pleasure in the people and sights of Israel and in each other was soul satisfying. Suddenly illness struck again and Leo died of a stroke in Haifa on 6 May 1976. He is survived by his wife Jeannie, their son Michael, and two grandchildren.

In the statistics profession Leo Katz will be remembered by some as a thesis adviser, by others as a faculty colleague, by some as a person who was active in professional societies, and, by all who knew him, as a friend. He will be sorely missed by all.

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